Charles Lyell, would later develop as a part of his uniformitarian attack on catastrophism: (1) an emphasis on noncatastrophic causes of the extinction of species, particularly (in Fleming's case) man's activities; (2) a tendency to reject the evidence for a progressive increase in the complexity and perfection of life during geologic time; (3) the idea that world climate might have been affected by an increase in the amount of land during the course of geologic history; and (4) the rejection of the theory of an originally molten earth that has slowly cooled down.

From 1824 to 1826, with Jameson's secret encouragement, Fleming engaged in a controversy with William Buckland in which he showed that Buckland's theory of a violent deluge contradicted both the Bible and the scientific evidence. Fleming argued that the Bible represented the deluge as nonviolent, and he attributed the so-called "diluvial" phenomena to local river floods, the bursting of lakes, and uprisings of the sea. In a controversy with William Conybeare in 1829, Fleming disputed the fossil evidence for a warmer climate in the past, insisting that our knowledge of the habits of an existing species can tell us nothing about the behavior of a similar, but not identical, fossil species, since every species is fixed and unique in its behavior.

Fleming had argued in his controversy with Buckland that there must be free inquiry in science without regard for the Bible, yet in his *History of British Animals* he adopted a scheme of reconciliation between geology and Genesis that was originally proposed by a friend, the Reverend Thomas Chalmers, on the basis of Cuvier's idea of successive creations. This theory, which was elaborated by Fleming in his *Lithology of Edinburgh* (1859), assumed that the "pre-Adamic" life had been totally destroyed by some extraordinary cause (probably the darkening of the sun) accompanied by debacles of water rushing over the earth. The species of animals and plants of the present epoch had then been created during the six days (or periods) described in Genesis. Similar revolutions, he believed, had initiated at least five previous epochs in earth history. Thus it can be seen that Fleming rejected Lyell's uniformitarian views for earth history as a whole. The idea of evolution was, of course, anathema to him, and we find him in 1854 citing Scripture in opposition to it.

Fleming was by nature conservative, reluctant to alter his views once they had been firmly established. The discrediting of neptunism around 1820 only served to reinforce his already skeptical attitude toward geological theory. His contributions to geology were therefore essentially negative—the effective criticism of inadequate theories. His views, which were relatively enlightened in the 1820's, when they were opposed to the catastrophist excesses of Cuvier and Buckland, were definitely outmoded by the 1850's. Despite his extensive zoological and paleontological knowledge (he was, for example, the first to discover the remains of fish in the Old Red Sandstone), Fleming had been trained in the old mineralogical school of geology and apparently never fully accepted the new geology, which relied boldly upon paleontological criteria in correlating strata.

BIBLIOGRAPHY

I. ORIGINAL WORKS. Fleming's most important works were *The Philosophy of Zoology*, 2 vols. (Edinburgh, 1822); *A History of British Animals* (Edinburgh, 1828); and *The Lithology of Edinburgh*, ed., with a memoir, by Rev. John Duns (Edinburgh, 1859).

A list of Fleming's works by Alexander Bryson, *Transactions of the Royal Society of Edinburgh*, **22** (1861), 675–680, is fairly complete (129 items, including two, nos. 80 and 109, which are not by Fleming according to W. E. Houghton, ed., *The Wellesley Index to Victorian Periodicals, 1824–1900*).

The list in the Royal Society of London *Catalogue of Scientific Papers* (*1800–1863*), II, contains fifty-three items, of which six are not in Bryson's list. The Royal Society *Catalogue*, however, has fuller and sometimes more correct entries, and it usually gives all the journals in which each article appeared. These lists do not cite all the articles by Fleming in the *Edinburgh Encyclopaedia, Encyclopaedia Britannica*, supp., vol. III (1824), *Edinburgh Monthly Review*, and *New Edinburgh Review*.

There are a few of Fleming's letters still extant, notably several to Lyell at the American Philosophical Society, Philadelphia.

II. SECONDARY LITERATURE. The memoir by Duns (see above) contains extracts from Fleming's correspondence. A memoir by Bryson in *Transactions of the Royal Society of Edinburgh*, **22** (1861), 655–675, emphasizes his scientific work. See also "Scottish Natural Science," in *North British Review*, **28** (1858), 39–55, by Duns, which is largely devoted to Fleming.

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FLEMING, JOHN AMBROSE (*b.* Lancaster, England, 29 November 1849; *d.* Sidmouth, Devon, England, 18 April 1945), *electrical engineering.*

The son of a Congregational minister, Fleming moved to London in 1863 and attended University College School and later University College, graduating in 1870. After a period of alternate science teaching and additional study, he entered Cambridge University in 1877 to work under James Clerk Maxwell in the new Cavendish Laboratory. There he helped to repeat the century-old electrical experiments of Henry Cavendish, whose notes on them had recently come to light. Fleming was made demonstrator in 1880, and in the following year he became professor of physics and mathematics in the newly constituted University College at Nottingham.

He resigned after a year to become a consultant to the Edison Electric Light Co. in London. In 1885 he was appointed professor of electrical technology at University College, a post he held for forty-one years. He made many contributions to the design of transformers, to the understanding of the properties of materials at liquid-air temperatures, to photometry, and to electrical measurements in general. He was an outstanding teacher; the right-hand rule (a mnemonic aid relating direction of magnetic field, conductor motion, and the induced electromotive force) is attributed to him. He was also a highly successful popular scientific lecturer.

At University College he experimented widely with wireless telegraphy and gave special courses on the subject. He was aware of Edison's observation of the "Edison effect" (he had visited the United States and met Edison in 1884) of unilateral flow of particles from negative to positive electrode, and he repeated some of the experiments, with both direct and alternating currents, beginning in 1889. During the following years, he cooperated with Marconi in many of his experiments and helped to design the transmitter employed by Marconi in spanning the Atlantic in 1901. Thus it was not until 1904 that he returned to his experiments on the Edison effect, with a view to producing a rectifier that would replace the inadequate detectors then used in radiotelegraphy. He named the resulting device a "thermionic valve," for which he obtained a patent in 1904. This was the first electron tube, the diode, ancestor of the triode and the other multielectrode tubes which have played such an important role in both telecommunications and scientific instrumentation.

Fleming led an incredibly active scientific life. He read the first paper ever presented to the Physical Society on its foundation in 1874 and read his last paper to the same body sixty-five years later, in 1939. His career covered the time from Maxwell to the advent of electronic television. He published more than a hundred important papers. He was an active president of the Television Society from 1930 until his death and received many other honors, including the Hughes Medal in 1910 from the Royal Society (he was made F.R.S. in 1892); the Faraday Medal of the Institution of Electrical Engineers (1928); and the Gold Medal of the Institute of Radio Engineers (1933). He was knighted in 1929. He became professor emeritus after his retirement in 1926 but continued to be scientifically active nearly until his death at the age of ninety-five. In 1933, when he was eighty-four, Fleming, whose first wife (Clara Ripley Pratt) had died in 1917, was married to Olive May Franks, who survived him. He had no children.

BIBLIOGRAPHY

I. Original Works. Fleming wrote several important texts and handbooks on electrical engineering, beginning with the 2-vol. treatise *The Alternate Current Transformer* (London, 1889–1892) and leading up to the monumental *Principles of Electric Wave Telegraphy* (London, 1906), which went into several editions and remained the standard work for many years; it is a rich source of historical information as well. Another of his books to have long-term influence was *The Propagation of Electric Currents in Telephone and Telegraph Conductors* (London, 1911). A collection of his papers is in the library of University College, London, which also houses his own library and a number of the earliest diodes.

II. Secondary Literature. A short illustrated biography published on the fiftieth anniversary of the invention of the diode, J. T. MacGregor-Morris, *The Inventor of the Valve* (London, 1954), contains a list of Fleming's books. The same author prepared the entry in *Dictionary of National Biography, 1941–1950.* There is an obituary by W. H. Eccles in *Obituary Notices of Fellows of the Royal Society*, no. 14 (Nov. 1945), and a tribute in *Notes and Records of the Royal Society* (Mar. 1955).

Charles Süsskind

FLEMING, WILLIAMINA PATON (*b.* Dundee, Scotland, 15 May 1857; *d.* Boston, Massachusetts, 21 May 1911), *astronomy.*

Mrs. Fleming's father, Robert Stevens, a craftsman whose shop sold picture frames, died when she was seven; her mother was Mary Walker Stevens. After a public school education in Dundee, she married James Orr Fleming on 26 May 1877, and they immigrated to Boston at the end of 1878. Shortly thereafter the marriage fell apart, and Mrs. Fleming found it necessary to support herself and her infant son, Edward Pickering Fleming, who was born 6 October 1879. In 1881, after a period of domestic work for Edward C. Pickering, the new director of the Harvard College Observatory, she became a full-time copyist and computer at the observatory itself.

At that time Pickering had just embarked on an extensive program of celestial photography. Through her studies of the objective prism spectrum plates, usually in collaboration with Pickering, Mrs. Fleming became the leading woman astronomer of her day. Her suspicions aroused by the spectral peculiarities she observed, she discovered more than 200 variable